

before, except that the yellow granules were very indistinct; and the obliques next the head could hardly be traced.

The other obliques were bright pink, edged with deep blue-purple. Caudal horn was green at base, and blue-purple elsewhere, the "blue-purple" being of the exact tint of very ripe inkberries. Horn short in proportion to size of the larvae.

The spiracles were dark in ovals of white, these ovals being encircled by faint blue-purple lines. They were small, and merged in the pink obliques

on six segments, but conspicuous on the others.

2 October. Stopped eating, being then 63 mm. long.

10 October. Pupated.

The pupa was 31 mm. long, neither stout nor slender, with a tongue-case 9 mm. long, and lying close against the body. Its color was green at first, and showed the dark obliques on the abdominal segments, but in two days it became bright brown. There was a point on the anal end, but no hook.

THE MALE ELEMENT THE ORIGINATING FACTOR IN THE DEVELOPMENT OF SPECIES.

BY JEROME MCNEILL, MOLINE, ILL.

Professor W. K. Brooks, in his study of the philosophy of heredity¹ has advanced a new theory which offers a reasonable explanation of the means by which ancestral characters may be preserved in any species and at the same time new variations transmitted to posterity. Without attempting to state the theory in full (this is the more unnecessary because it is probably known to a large majority of the readers of *PSYCHE*), it will be sufficient for the present purpose to say that the author considers that "the male element is the originat-

ing and the female the perpetuating factor in the evolution of species." Mr. Brooks offers no more convincing arguments in support of his views than the evidence from sexual characters, and while the illustrations drawn from entomology are probably the best that could be selected, it has seemed to the writer that it might not be uninteresting to note the application of the theory to the genera and species of as little known and little studied an order as that of orthoptera. In presenting this evidence I shall collocate it with the five propositions formulated by Mr. Brooks.

1. "In most animals of separate sexes, the males of allied species differ

¹ The law of heredity, by W. K. Brooks, Associate on biology at Johns Hopkins university. Published by John Murphy and co., Baltimore.

more than the females from the ancestral type."

In the first place, assuming that the larvae and pupae are more like the ancestral forms than the imago, the females show less divergence from this form than the males in being more frequently apterous or abortive winged. When the wings are fully developed they are as a rule smaller relatively if not absolutely in the female, and there is perhaps no notable exception to this rule. The females also approach more nearly to the ancestral type in the frequently less developed antennae.

Throughout the order it is very generally true that the coloration is brighter and more contrasting in the male. In *Pezotettix viridulus* the male is bright pea green (in living specimens) with black pleural stripes while in the female the color is nearly uniformly dull brown. In the wings of most *oedipodae* the transverse black or fuliginous band is more extended in the male as are also the similarly colored spots in the usually transparent apex. In the same family the fuscous spots and bands of the elytra are not infrequently much deeper in color in the male. The genus *Acridium* offers some exception to this rule of coloration since, while on the whole the males are more brilliantly colored, certain species have the elytra as well as the head and pronotum absolutely spotted or unicolored in the male, and absolutely or distinctly spotted in the female, the latter being much more variable in this respect. This apparent departure from the rule may possibly be

explained by the females retaining longer a larval or ancestral character. Unfortunately I have no knowledge of the larvae of these species to help me in deciding this point. But in the allied genus *Melanoplus* it is certain that the larvae are in many species much more spotted and streaked than the imagos. In *mantidae* generally the males have the elytra distinctly more membranous than the females. Since the elytra are, in orthoptera generally, protective in color and form as well as in structure, it might be expected that the only carnivorous family needing this protection least would be the first to outgrow it and it is quite in accord with Mr. Brooks's theory of heredity to find the males of *mantidae* leading the females in this change. In the genus *Melanoplus* the males show in the club-shaped abdomen a marked departure from the usual subcylindrical or tapering form of this part which is common in the saltatorial division of the order. The males of this genus and its allies *Pezotettix* and *Acridium* exhibit a peculiar development of the anal cerci which are generally of the simplest and most regular form in this family.

Finally the much more attenuate forms of the males of *phasmidae* certainly show them to be in advance of the stouter females in their divergence from the typical orthopterous form.

2. "Those organs that are confined to males or are of more importance or are more perfectly developed in them than in the females are much more likely to give rise to hereditary modifi-

cations than parts which are confined to or are more perfectly developed in females."

On this point it will be sufficient to call to mind that the organ which is almost entirely restricted to the males of *locustidae*, *gryllidae*, and *acrididae* is the musical apparatus. In *acrididae* this apparatus is too little specialized to repay examination. In *locustidae* and *gryllidae* there is little evidence to be found of an unmistakable character, but the last mentioned family has one genus *Oecanthus* and the first mentioned two genera *Conocephalus* and *Orchelimum* which throw some light on the subject. Concerning *Oecanthus* I may say that the three most common species are *nivens*, De Geer, *angustipennis*, Fitch, and *fasciatus* Fitch. These species are usually considered to be mere varieties, and although I am satisfied that the distinctions of form and habits and to a less degree of color entitle them to rank as species, their very distinct "songs" leave scarcely any room for doubt. Of course this difference in the character of stridulation is accompanied by a certain, though not conspicuous, difference in the structure of the stridulating apparatus, and by its tending to vary in structure and use, it aids greatly in establishing two species. In *Conocephalus* and *Orchelimum* the evidence is similar. The species for the most part are very similar and the most certain means of distinguishing them is in their songs.

3. "That a part which is confined to or is most developed in males is more

likely than a similar female part to vary."

This principle is well illustrated in the anal cerci of the males of *Melanoplus*, *Pezotettix*, and *Acridium*.

This part which has been before remarked in the females is simple and constant in form, in the males is extremely variable in size and shape, so that in the two genera first mentioned, at least, it furnishes the best specific characters for distinguishing the species. In these genera also the males furnish good specific characters in the form of the last ventral segment, while in the female this part is very constant in form.

4. "That males are, as a rule — more variable than females."

Much of the evidence already given bears upon this point — and I will content myself with a very few more examples.

The males of two species of *Tridactylus*, *T. apicalis* Say and *T. terminalis* Uhler have the anterior tibiae furnished with a very remarkable appendage.

The tibiae are divided into two forks nearly at right angles to each other. That fork which occupies the usual position of the tibiae ends in two strong spines. From its base the true tibia extends backward parallel with the thigh, with which it forms a raptorial apparatus. This branch ends in a strong curved claw — and a very diminutive tarsus which is placed at right angles to the tibiae. In these species the males are further distinguished from the females by the swollen pronotum.

In the genera *Centrophilus* and

Udeopsylla the males are very generally distinguished by the larger and more numerous spines on the lower margin of the posterior femora.

5. "That the male leads and the female follows in the evolution of new races."

Little remains to be said on this point since nearly all that has gone before shows already that in *orthoptera* male characters lead in the recognition if not in the evolution of new species. No student of orthoptera will question the statement that were it not for the variation of the cerci and the last ventral segments of the males of *Melanoplus* and *Pezotettix* it would not be possible to recognize nearly so many species in these genera as are now known to exist. It is also indisputable that in *Melanoplus* especially in several instances, it is practically impossible to distinguish with certainty between the females of closely allied species. Examples are not wanting of cases in which the males differ so greatly from the females, that they have been placed when first described in different genera. The male of *Chlocaltis conspersa* Harr., differs so much from the female that Mr. Scudder in his ignorance of their relationship was

quite justified in describing the male as *Stenobothrus melanopleurus*. The males of *Syrbula admirabilis* Uhler are of two forms; the green one, which is very rare, resembles the female in coloration but differs in structural characters, and especially in the clavate antennae. The dark form, in addition to the structural features which are very similar to those of the green form, is so very different in coloring that it was for a long time widely separated from the female, and as genera are now made, the sexes may be considered generically distinct.

It will be seen that orthoptera furnish strong, if not striking, corroborative evidence of the truth of Mr. Brooks's theory of heredity. While I do not pretend, in this hasty review, to have exhausted the illustrations that might be furnished by the species and families represented in the United States I have not found any controvertive evidence except the considerable variation in the length and shape of the ovipositor of *Xiphidium*, that of the closely allied genus *Orchelimum* being quite constant, and the less marked variation in the length of the same organ in *Conocephalus*, *Thyreonotus* and *Gryllus*.